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玉米銹病發生與氣象因子及其產量損失

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摘　　要

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玉米銹病在本省有普通型（由 *Puccinia sorghi* 引起）及南方型（由 *P. polysora* 引起）兩種。然而，目前以南方型銹病發生較為普遍。銹病病勢進展一般呈開口向下之二次方曲線，但發病較重時則呈一次方直線。銹病的發生和氣象因子有關，春作玉米南方型銹病的發生和發病7天前之溫度24.1～28.0℃及28.1～32.0℃相關最大，秋作玉米則和8～14天前之溫度20.1～24.0℃、24.1～28.0℃及28.1～32.0℃相關最大。利用複迴歸分析銹病病斑面積率及侵染速率和氣象因子之關係可得到迴歸方程式，將不同年代、不同期作之氣象因子代入方程式時可得到預測值，經比較預測值與實測值甚為接近，可做為預測之用。

在產量損失方面，本省尚缺有關研究報告。在國外，Russell 1965年報告，普通型銹病利用6個雜交組合經過兩年的結果，其產量損失在15.3～23.5%。Kim及Brewbaker 1976年報告普通型銹病對產量及農藝性狀之影響，在子實產量有35%之減產，在鮮草重有27%之損失，在穗長有11%之差異，在穗徑有10%之不同，在株高、穗位高及吐絲期有5%之差別。Randle等1984年利用兩個甜玉米品系 Jubilee（中感）及 Stylepak（感）觀察其農藝性狀之差異，結果顯示在銹病發生區及無銹病區在吐絲期，穗長、穗徑及果穗含水率均有明顯的差異。Pataky 1987年利用甜玉米品系 Gold Cup（中抗）、Stylepak（感）及Florida Staysweet（感）來比較普通型銹病引起之產量損失，結果顯示收穫前一週調查時每10%銹病引起6%穗重及6.5%穗數之損失。在南方型銹病方面，Rodriguez-Ardon等1980年報告利用感病雜交品系在1976及1978年從5月25日開始每隔兩週種植一次，共種三次，其子實產量減產4、23及45%，所以晚植者產量損失特別高。

(關鍵字：玉米銹病，氣象因子，產量損失)

緒　　言

本省近年來 (1984～1990) 玉米銹病發生的情形(表一)，顯示春作玉米比秋作玉米銹病發生的百分率為大，而主要銹病發生地區係在彰化、雲林、嘉義、花蓮及台東等地。

本省玉米銹病有普通型（由 *Puccinia sorghi* 引起）及南方型（由 *P. polysora* 引

表一、本省近年來(1984～1990)玉米銹病發生面積(公頃)

Table 1. Areas of corn rust from 1984～1990 in Taiwan (Hectares)

地區 Location	1984 春作 Spring crop	1984 秋作 Fall crop	1985 春作 Spring crop	1985 秋作* Fall crop	1986 春作* Spring crop	1986 秋作 Fall crop	1987 春作 Spring crop	1987 秋作 Fall crop	1988 春作 Spring crop	1988 秋作 Fall crop	1989 春作 Spring crop	1989 秋作 Fall crop	1990 春作 Spring crop
桃園區												4.0	
台中區	136.2	141.6	250.0			67.3			88.4	237.8	190.8	270.6	660.0
台南區	820.0	579.7	146.3			54.0	221.3	98.5	347.0	112.5	1207.9	1.0	421.4
高雄區		76.8	18.6			9.1	36.0	17.7	16.7	29.2	10.0	13.9	3.6
台東區	276.0	85.0	708.0			245.0	—	—	850.0	289.0	1540.0	452.0	647.0
花蓮區	1670.0	—	3111.1			1580.3	3849.6	—	429.5	2307.8	3005.7	1289.9	2808.8
總　計	2902.2	883.1	4648.9			1955.7	4106.9	116.2	1731.6	2976.3	5954.4	2031.4	4540.8
栽培面積	16463.0	16999.0	20525.0			23754.0	22642.0	23557.0	24893.0	25720.0	25570.0	23674.0	24629.0
百分率(%)	17.6	5.2	22.6			8.2	18.1	0.5	7.0	11.6	23.3	8.6	18.4

註：1.* 爲缺資料。— 爲不發生。

2.發病面積資料來自臺灣省植物保護工作檢討報告，臺灣省政府農林廳備印，中華民國 73年～79年。

3.栽培總面積資料來自臺灣農業年報，臺灣省政府農林廳編印，民國八十年版，1991年6月。

4.百分率爲發病總面積／栽培總面積×100%。

起）兩種，由於玉米在本省栽培時間已久，所以普通型銹病可能早已存在，然而南方型銹病直到1976年才有報告[1]。南方型是目前飼料玉米最重要的葉部病害，甜玉米則兩種銹病均會發生[3]。

由於玉米銹病菌之生物學及抗病檢定已另有報告[2,3]，本報告僅就銹病發生與氣象因子之關係[5]及銹病引起之產量損失提出報告，以供參考。

銹病病勢進展

玉米銹病的病勢進展通常爲呈開口向下之二次方曲線，但若發病嚴重，病勢進展較快時則呈一次方直線(表二)。此與Headrick及Pataky[7]之報告(表三)相同。

表二、民國78年及79年玉米不同地點各品種之南方型銹病病勢進展之迴歸方程式

Table 2. Regression equations of southern rust disease development on different cultivars of corn at various locations during 1989 and 1990

地點 Location	玉米品種 Cultivar	迴歸方程式 Regression equation	決定係數 R^2 Determination coefficient
78年春作(Spring crop, 1989)			
台中本所	哈蜜236	$Y^a=-3.7603+0.3711D-0.0132D^2$	0.8116*[b]
	M2	$Y=-7.5647+0.5173D-0.0158D^2$	0.8491*
	台南15號	$Y=-8.2757-0.1289D+0.0053D^2$	0.5958
嘉義分所	哈蜜236	$Y=-7.8664+0.5667D-0.0138D^2$	0.6285
	M2	$Y=-3.9855+0.0957D$	0.7318*
	台南15號	$Y=-5.7189+0.1249D$	0.5035
嘉義六腳鄉	哈蜜236	$Y=-6.5849+0.3521D-0.0071D^2$	0.6514*
	M2	$Y=-8.5769+0.3866D-0.0053D^2$	0.8800*
	台南15號	$Y=-9.0519+0.4349D-0.0071D^2$	0.8366*
78年秋作(Fall crop, 1989)			
台中本所	台南 5號	$Y=-9.0231+0.2549D-0.0046D^2$	0.4848**
	台農351號	$Y=-9.9520+0.3067D-0.0058D^2$	0.5172**
	M2	$Y=-10.1824+0.2761D-0.0056D^2$	0.5448**
	哈蜜236	$Y=-10.2543+0.3832D-0.0080D^2$	0.6183**
	H7	$Y=-7.1669+0.1164D-0.0025D^2$	0.3765**
	H41	$Y=-11.1238+0.4099D-0.0080D^2$	0.6117**
嘉義分所	哈蜜236	$Y=-5.2457+0.1062D$	0.6758*
	M2	$Y=-3.8165+0.0927D$	0.9316**
	台南15號	$Y=-5.1611+0.1211D$	0.9089**
嘉義六腳鄉	哈蜜236	$Y=-4.8358+0.0839D$	0.5451
	M2	$Y=-7.6735+0.1969D$	0.8242*
	台南15號	$Y=-7.1443+0.1591D$	0.8238*
79年秋作(Fall crop, 1990)			
嘉義義竹鄉	台南17號	$Y=-4.94307+0.08297D$	0.9527**
嘉義朴子鎮	台農 1號	$Y=-4.10074+0.08119D$	0.8709**
嘉義六腳鄉	台農 1號	$Y=-4.91076+0.06425D$	0.9334**
嘉義太保市	哈蜜236	$Y=-6.16611+0.10763D$	0.9784**

[a] 以Ln X/(1-X)轉換之感染病斑面積率，D爲發病後日數。

[b] **極顯著，*顯著。

[a] Infected leaf area percentage transformed by Ln X/(1-X), D=days after disease occurrence.

[b] ** Significant at 1% level, * Significant at 5% level.

表三、利用線性迴歸方程式描述普通型銹病散佈在甜玉米雜交品系(Florida Staysweet和Sugar Loaf)的情形

Table 3. Least squares linear regression equations describing common rust spread on sweet corn hybrids Florida Staysweet and Sugar Loaf at Urbana, IL, in 1984 and 1985[a]

Hybrid[b]	Year	Days agter inoculation	Incidence[c]	r^{2d}	Severity[e]	r^2
FSS	1984	19	$Y=1.75-5.18X+3.26X^2$	0.98	$Y=-1.45-0.094X$	0.79
		29	$Y=5.55-10.25X+7.19X^2$	0.99	$Y=-1.11-1.07X+0.70X^2$	0.99
		36	NS		$Y=-0.79-0.73X^{*f}$	0.96
		47	NS		$Y=-0.18-2.15X+1.26X^2$	0.99
FSS	1984	20	$Y=3.72-3.18X$	0.86	$Y=-1.00-0.54X$	0.87
		30	$Y=6.13-6.07X+3.87X^2$	0.99	$Y=-0.69-0.58X^*$	0.94
		36	NS		$Y=-0.46-0.65X^*$	0.95
		48	NS		$Y=-0.16-0.54X^*$	0.92
SL	1984	19	$Y=-0.22-1.03X$	0.99	$Y=-1.45-0.16X$	0.87
		29	$Y=0.80-1.69X$	0.96	$Y=-1.51-0.065X$	0.81
		36	$Y=1.66-2.56X$	0.96	$Y=-1.37-0.22X$	0.89
		47	$Y=2.92-5.90X+2.72X^2$	0.99	$Y=-1.25-0.61X+0.34X^2$	0.99
SL	1984	20	NS		NS	
		30	$Y=0.99-0.88X$	0.92	$Y=-1.37-0.16X$	0.82
		36	$Y=1.20-0.55X$	0.96	$Y=-1.38-0.12X$	0.87
		48	$Y=4.83-7.32+3.75X^2$	0.99	$Y=-1.30-0.16X$	0.92

(Headrick, J. M., and Pataky, J. K. 1988)

[a] Gompit-transformed incidence and severity regressed on $\log_{10}$ distance from focus.
[b] FSS = Florida Staysweet, SL = Sugar Leaf.
[c] Measured as the proportion of diseased leaves per plant. Model and polynomial terms significant at $P<0.05$. NS = Not Significant.
[d] Coeffiecnt of simple determination.
[e] Measured as the percentage of the total plant leaf area infected. Model and polynomial terms significant at $P<0.05$. NS = Not significant.
[f] Slop significantly different from Sugar Loaf in the same year at the same number of days after inoculation.

銹病和氣象因子的關係

春作玉米南方型銹病和發病前7天之溫度24.1～28.0℃及28.1～32.0℃相關最大，而秋作玉米則和8～14天前之溫度20.1～24.0℃、24.1～28.0℃及28.1～32.0℃之相關最大[4]（表四、五）。

表四、台中本所78年春作各玉米品種之南方型銹病病斑面積率增加[a]和發病前7天溫度之相關係數

Table 4. Correlation coefficient of increasing infected leaf area percentage of southern corn and 7 days temperature ahead

溫 度 Temperature	品 種 Cultivar 哈蜜236	 M2	 台南15號
16.1～20.0℃	-0.2047	-0.3959*	-0.2250
20.1～24.0℃	-0.3733	-0.4782*	-0.2767
24.1～28.0℃	0.7462**[b]	0.5120**	0.7666**
28.1～32.0℃	0.4117*	0.7153**	0.4282*

[a] 病斑面積率增加=每星期病害增加之百分率。
[b] *顯著，**極顯著。
[a] Increasing infected leaf area percentage=percentage of disease increase every week.
[b] * Significant at 5% level, ** Significant at 1% level.

表五、台中本所78年秋作各玉米品種之南方型銹病病斑面積率增加[a]和發病前8～14天溫度之相關係數

Table 5. Correlation coefficient of increasing infected leaf area percentage of southern corn and 8-14 days' temperature ahead

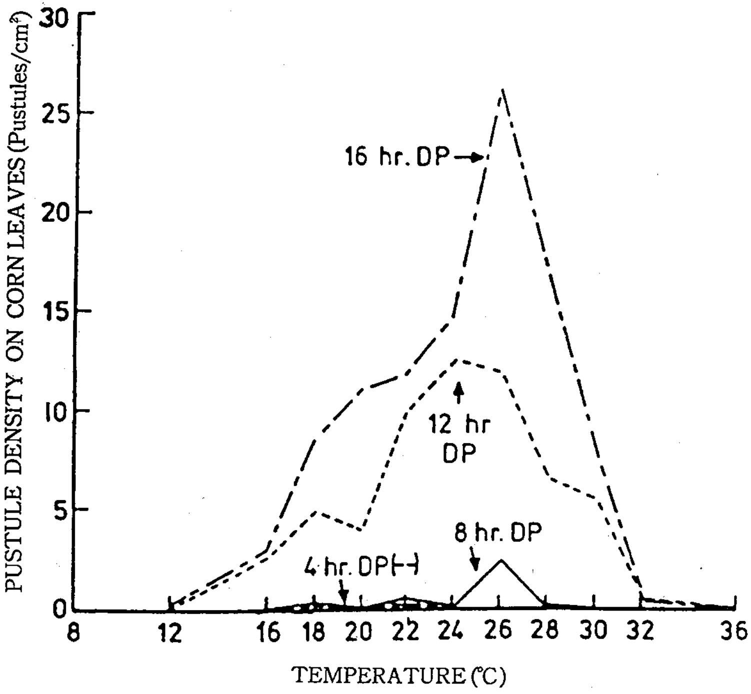
溫 度 Temperature	品 種 Cultivar TN 5[b]	 TR351	 M2	 Honey 236	 H7	 H41
16.1～20.0℃	-0.0853	-0.0842	0.3651	-0.1352	-0.0322	0.0263
20.1～24.0℃	0.6002**[c]	0.4358*	0.2892	0.3222	0.1738	0.6111**
24.1～28.0℃	0.6368**	0.4199*	0.5387**	0.4391*	0.6058**	0.6077**
28.1～32.0℃	0.5111**	0.4211*	0.4173*	0.3075	0.3465	0.4402*

[a] 病斑面積率增加=每星期病害增加之百分率。
[b] TN5(台南5號)及TR351(台農351)爲飼料玉米，M2及Honey 236爲甜玉米，H7及H41爲青割玉米。
[c] *顯著，**極顯著。
[a] Increasing infected leaf area percentage=percentage of disease increase every week.
[b] TN5(Tainan5) and TR351(Tainung351) are feed corn, M2 and Honey236 are sweet corn, H7 and H41 are forage corn.
[c] * Significant at 5% level, ** Significant at 1% level.

Hollier及King[8]報告，南方型銹病菌通常需要有露水才會侵染，但在8、12、36或40℃時不管露水時間有多長均不侵染。在16小時之露水時間下，26℃的溫度是侵染最適溫度，此時夏胞子堆的數目是12小時露水時間的2倍。在4小時及8小時之露水時間，各種不同溫度下其胞子堆數目不多（圖一）Headrick及Pataky[6]報告普通型銹病在甜玉米之侵染在20℃下以12小時(30分鐘開，30分鐘關)之斷續噴霧最佳(圖二)，在白天溫度32及24℃下，夜間溫度以24℃及16℃發病最好(圖三)，夜間溫度8℃時則延長潛伏期約2天，32℃時夏胞子形成甚少。

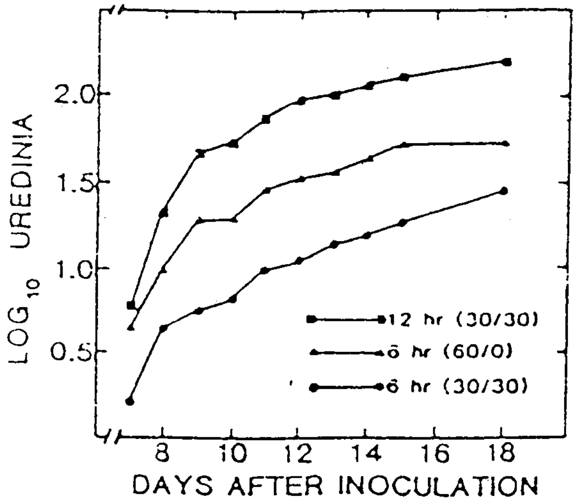
病斑面積率和氣象因子之關係

分析玉米銹病發病高峰期前7天之氣象因子和病斑面積率增加（Y_2-Y_1, Y_2及Y_1爲前後兩次病斑面積率）之關係。氣象因子分爲最高溫、最低溫、平均溫、平均最低溫、平均最高溫、最高相對濕度、最低相對濕度、平均相對濕度、平均最高及最低相對濕度，氣溫16.1～20.0℃，20.1～24.0℃，24.1～28.0℃及28.1～32.0℃之累積小時數。分析後得到許多方程式，再由其中挑選出決定係數高且達顯著水準者，得到8個方程式(表六)。這些方程式以不同年代、不同地點及不同玉米品種發病高峰期之前7天之氣象因子代入方程式所得之預測值與實測值之葉片病斑面積率增加比較(表七、八、九)。由表七知預測方程式1、2、5及6預測值與實測值相近，方程式3、4、7及8爲預測發病較重的方程式，在發病輕微時預測不準。由表八知所有8個預測方程式預測值與實測值均甚相近。由表九知，除了方程式7及8外，其餘預測值與實測值均甚相近。



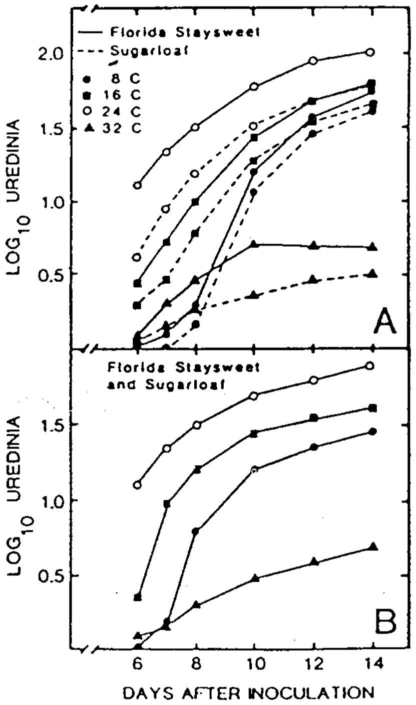
圖一、在溫度8～36℃及露水時間(DP)4、8、12及36小時下，南方型銹病菌（*Puccinia polysora*）在玉米葉片上侵染造成之胞子堆密度。(Hollier, C. A., and king, S. B. 1985)

Fig. 1. Infection expressed as pustule density on maize by *Puccinia polysora* at temperatures of 8～36℃ and periods of 4、8、12 and 16 hr



圖二、不同噴霧時間，在甜玉米雜交品系Florida Staysweet上感染普通型銹病菌（*Puccinia sorghi*）夏胞子堆的數目。

Fig. 2. Log_{10} number of *Puccinia sorghi* uredinia on two inoculated leaves per plant of the sweet corn hybrid Florida Staysweet after exposure to mist periods of 6 hr of constant mist, 6 hr of 30 min on /30 min off, and 12 hr of 30 min on /30 min off.



圖三、不同夜溫及晝溫在甜玉米雜交品系Florida Staysweet和Sugar Loaf上感染普通型銹病菌（*Puccinia sorghi*）夏胞子堆的數目。

Fig. 3. Log_{10} number of *Puccinia sorghi* uredinia on two Florida Staysweet and Sugar Loaf at four night temperature（8、16、24 and 32℃）with day temperatures of (A) 32℃ and (B) 24℃.

表六、民國79年嘉義地區秋作玉米南方型銹病病斑面積率增加與氣象因子之關係

Table 6. The correlation of increasing infected leaf area percentage of southern rust disease on corn and meteorological factors during fall crop, 1990 at Chia-yi area

代號 No	迴歸方程式 Regression equation	決定係數 R^2 Determination coefficient
	品種：台農1號　地點：六腳鄉	
1.	$Y^a=10.3981-0.0859X_2+0.5336X_3-0.2764X_4$	0.8545**[b]
2.	$Y=8.1772-0.0817X_2+0.4230X_3-0.1923X_5$	0.8078*
3.	$Y=0.5633-0.1011X_1+0.6947X_3-0.1522X_4$	0.8285*
4.	$Y=-1.3073-0.1027X_1+0.6624X_3-0.1047X_5$	0.8120*
	品種：台南17號　地點：義竹鄉	
5.	$Y=24.1086-0.2099X_2+0.7254X_3-0.4301X_4$	0.9485**
6.	$Y=19.9031-0.2022X_2+0.5527X_3-0.2901X_5$	0.8946**
7.	$Y=5.6786-0.2181X_1+0.9071X_3-0.1526X_4$	0.8277*
8.	$Y=2.0349-0.2245X_1+0.9173X_3-0.0930X_5$	0.8150*

[a] Y爲病斑面積率增加，X_1爲20.1～24.0℃累積小時數，X_2爲24.1～28.0℃累積小時數，X_3爲平均最高溫，X_4爲平均相對濕度，X_5爲平均最高濕度。

[b] * 顯著，** 極顯著。

[a] Y=Increasing infected leaf area percentage, X_1=Accumulative hours 20.1～24.0℃, X_2 = Accumulative hours 24.1～28.0℃, X_3=Ave. highest temp. X_4 =Ave. RH. X_5 =Ave. highest RH.

[b] * Significant at 5% level, ** Significant at 1% level.

表七、葉片病斑面積率增加之預測值與民國78年六腳鄉春作實測值比較

Table 7. Comparison of predicted and observed values on increasing infected leaf area percentage southern rust on corn during spring crop, 1989 at Liu-chao

代號 No	預測方程式 Predicted equation	預測值 Predicted value	實測值[c] Observed value
1.	$Y^a=10.3981-0.0859X_2+0.5336X_3-0.2764X_4$ (R^2=0.8545**[b])	1.21	1.45
2.	$Y=8.1772-0.0817X_2+0.4230X_3-0.1923X_5$ (R^2=0.8078*)	2.36	1.45
3.	$Y=0.5633-0.1011X_1+0.6947X_3-0.1522X_4$ (R^2=0.8285*)	9.58	1.45
4.	$Y=-1.3073-0.1027X_1+0.6624X_3-0.1047X_5$ (R^2=0.8120*)	9.10	1.45
5.	$Y=24.1086-0.2099X_2+0.7254X_3-0.4301X_4$ (R^2=0.9485**)	4.07	4.50
6.	$Y=19.9031-0.2022X_2+0.5527X_3-0.2901X_5$ (R^2=0.8946**)	5.70	4.50
7.	$Y=5.6786-0.2181X_1+0.9071X_3-0.1526X_4$ (R^2=0.8277*)	19.54	4.50
8.	$Y=2.0349-0.2245X_1+0.9173X_3-0.0930X_5$ (R^2=0.8150*)	19.66	4.50

[a] Y爲病斑面積率增加，X_1爲20.1～24.0℃累積小時數，X_2爲24.1～28.0℃累積小時數，X_3爲平均最高溫，X_4爲平均相對濕度，X_5爲平均最高濕度。

[b] * 顯著，** 極顯著。

[c] 實測值爲M2玉米。

[a] Y=Increasing infected leaf area percentage, X_1=Accumulative hours 20.1～24.0℃, X_2 = Accumulative hours 24.1～28.0℃, X_3=Ave. highest temp., X_4 =Ave. RH, X_5 = Ave. highest RH.

[b] * Significant at 5% level, ** Significant at 1% level.

[c] Observed value from cultivar M2.

表八、葉片病斑面積率增加之預測值與民國79年嘉義地區秋作實測值比較

Table 8. Comparison of predicted and observed values on increasing infected leaf area percentage of southern rust on corn during fall crop, 1990 at Chia-yi area

代號 No	預測方程式 Predicted equation	預測值 Predicted Value	實測值[c] Observed value 義竹 I-tzu	六腳 Liu-chao	朴子 Pou-tzu	太保 Thai-pao
1.	Y^a=10.3981-0.0859X_2 +0.5336X_3-0.2764X_4 (R^2=0.8545**[b])	1.50	-[c]	2.30	1.80	2.75
2.	Y= 8.1772-0.0817X_2 +0.4230X_3-0.1923X_5 (R^2=0.8078*)	1.75	-	2.30	1.80	2.75
3.	Y= 0.5633-0.1011X_1 +0.6947X_3-0.1522X_4 (R^2=0.8285*)	2.03	-	2.30	1.80	2.75
4.	Y=-1.3073-0.1027X_1 +0.6624X_3-0.1047X_5 (R^2=0.8120*)	2.19	-	2.30	1.80	2.75
5.	Y=24.1086-0.2099X_2 +0.7254X_3-0.4301X_4 (R^2=0.9485**)	5.82	6.30	-	-	-
6.	Y=19.9031-0.2022X_2 +0.5527X_3-0.2901X_5 (R^2=0.8946**)	6.18	6.30	-	-	-
7.	Y=5.6786-0.2181X_1 +0.9071X_3-0.1526X_4 (R^2=0.8277*)	6.91	6.30	-	-	-
8.	Y= 2.0349-0.2245X_1 +0.9173X_3-0.0930X_5 (R^2=0.8150*)	7.07	6.30	-	-	-

[a] Y為病斑面積率增加，X_1為20.1～24.0℃累積小時數，X_2為24.1～28.0℃累積小時數，X_3為平均最高溫，X_4為平均相對濕度，X_5為平均最高濕度。

[b] * 顯著，** 極顯著。

[c] 無調查資料。

[d] 實測值義竹為台南17號，六腳鄉為台農1號，朴子為台農1號，太保為哈蜜236。

[a] Y=Increasing infected leaf area percentage, X_1=Accumulative hours 20.1～24.0℃, X_2 = Accumulative hours 24.1～28.0℃, X_3=Ave. highest temp., X_4 =Ave. RH, X_5 =Ave. highest RH.

[b] * Significant at 5% level, ** Significant at 1% level.

[c] no data.

[d] Observed value of I-tzu is Tainan 17, Liu-chao is Tainung 1, Pou-tzu is Tainung 1, Thai-pao is Honey 236.

表九、葉片病斑面積率增加之預測值與民國80年台中春作實測值比較

Table 9. Comparisom of predicted and observed values on increasing infected leaf area percentage of southern rust on corn during spring crop, 1991 at Taichung

代號 No	預測方程式 Predicted equation	預測值 Predicted Value	實測值 Observed value 品種 Cultivar TN17	TN5	TNG1	H41	Honey 236	M2
1.	$Y^a=10.3981-0.0859X_2+0.5336X_3-0.2764X_4$ ($R^2=0.8545^{**}$)	1.20	0	0.40	0.15	0.02	2.47	0.01
2.	$Y=8.1772-0.0817X_2+0.4230X_3-0.1923X_5$ ($R^2=0.8078^{*}$)	0.36	0	0.40	0.15	0.02	2.47	0.01
3.	$Y=0.5633-0.1011X_1+0.6947X_3-0.1522X_4$ ($R^2=0.8285^{*}$)	1.81	0	0.40	0.15	0.02	2.47	0.01
4.	$Y=-1.3073-0.1027X_1+0.6624X_3-0.1047X_5$ ($R^2=0.8120^{*}$)	2.31	0	0.40	0.15	0.02	2.47	0.01
5.	$Y=24.1086-0.2099X_2+0.7254X_3-0.4301X_4$ ($R^2=0.9485^{**}$)	0.22	0	0.40	0.15	0.02	2.47	0.01
6.	$Y=19.9031-0.2022X_2+0.5527X_3-0.2901X_5$ ($R^2=0.8946^{**}$)	1.15	0	0.40	0.15	0.02	2.47	0.01
7.	$Y=5.6786-0.2181X_1+0.9071X_3-0.1526X_4$ ($R^2=0.8277^{*}$)	6.45	0	0.40	0.15	0.02	2.47	0.01
8.	$Y=2.0349-0.2245X_1+0.9173X_3-0.0930X_5$ ($R^2=0.8150^{*}$)	7.10	0	0.40	0.15	0.02	2.47	0.01

[a] Y爲病斑面積率增加，X_1爲20.1～24.0℃累積小時數，X_2爲24.1～28.0℃累積小時數，X_3爲平均最高溫，X_4爲平均相對溼度，X_5爲平均最高溼度。

[b] * 顯著，** 極顯著。

[a] Y=Increasing infected leaf area percentage, X_1=Accumulative hours 20.1～24.0℃, X_2 = Accumulative hours 24.1～28.0℃, X_3=Ave. highest temp., X_4 =Ave. RH, X_5 =Ave. highest RH.

[b] * Significant at 5% level, ** Significant at 1% level.

侵染速率和氣象因子之關係

分析玉米銹病發病高峰期前 7 天之氣象因子和侵染速率（R, $R=1\times[Ln(Y_2/1-Y_2)-Ln(Y_1/1-Y_1)]/t_2-t_1$），($t_2$及$t_1$爲日數，$Y_1$及$Y_2$爲病斑面積率)之關係。氣象因子和前項分析病斑面積率之氣象因子相同。分析後得到11個方程式(表十)，這些方程式之決定係數均達顯著水準。若以不同年代、不同地點及不同玉米品種發病高峰期前 7 天之氣象因子代入方程式所得之預測值與實測值比較(表十一、十二、十三)。由表十一知方程式5、7、8、9、10及11預測值與實測值相近。由表十二知方程式除5及6外，其餘預測值與實測值均接近。由表十三知除方程式1外，其餘預測值與實測值甚接近。

表十、民國79年嘉義地區秋作玉米南方型銹病侵染速率與氣象因子之關係

Table 10. The correlation of infection rate of southern rust disease on corn and meteorological factors during fall crop, 1990 at Chia-yi area

代號 No	迴歸方程式 Regression equation	決定係數 R^2 Determination coefficient
	品種：台農1號 地區：六腳鄉	
1.	R^a=-1.8281-0.0421X_2+0.4130X_5-0.0907X_{10}	0.8810**[b]
2.	R=-0.2291-0.0352X_2+0.2428X_8-0.0492X_{10}	0.8993**
3.	R=-1.1703-0.0366X_2+0.2405X_8-0.0315X_{11}	0.8629*
4.	R=-1.2839-0.0369X_2+0.2797X_8-0.0491X_{12}	0.9107**
5.	R= 4.5268-0.0469X_4+0.1820X_6-0.0853X_{10}	0.8591*
6.	R= 3.7176-0.0522X_4+0.2182X_6-0.0902X_{12}	0.8662*
7.	R= 3.7086-0.0254X_3+0.1564X_8-0.0908X_{10}	0.8429*
	品種：台南17號 地區：義竹鄉	
8.	R= 3.0481-0.0349X_4+0.1271X_6-0.0569X_{10}	0.8050*
9.	R= 1.8326-0.0371X_4+0.1269X_6-0.0367X_{11}	0.7590*
10.	R= 1.8653-0.0338X_4+0.1115X_7-0.0513X_{10}	0.7714*
11.	R= 3.0801-0.0343X_4+0.0914X_9-0.0588X_{10}	0.7419*

[a] R爲侵染速率($R=1x〔Ln(y_2/1-y_2)-Ln(y_1/1-y_1)〕/t_2-t_1$)，$t_1$,$t_2$爲時間，$y_1$,$y_2$ 爲先後兩次病斑面積率，X_2 爲20.1～24.0℃累積小時數，X_3爲24.1～28.0℃累積小時數，X_4爲28.1～32.0℃累積小時數，X_5爲最高溫，X_6爲最低溫，X_7爲平均溫，X_8爲平均最高溫，X_9爲平均最低溫，X_{10}爲平均相對濕度，X_{11}爲平均最高濕度，X_{12}爲平均最低濕度。

[b] * 顯著，** 極顯著。

[a] R=Infection rate=$1x〔Ln(y_2/1-y_2)-Ln(y_1/1-y_1)〕/t_2-t_1$)，$t_1$,$t_2$=Time, y_1,y_2=Infected leaf area percentage, X_2= Accumulative hours 20.1～24.0℃, X_3=Accumulative hours 24.1～28.0℃, X_4 =Accumulative hours 28.1～32.0℃, X_5= Highest temp., X_6=Lowest temp., X_7= Ave. temp., X_8 =Ave. highest temp., X_9=Ave. lowest temp., X_{10} = Ave. RH, X_{11} =Ave. highest RH, X_{12}= Ave. lowest RH.

[b] * Significant at 5% level, ** Significant at 1% level.

表十一、銹病侵染速率之預測值與民國78年六腳鄉春作實測值比較

Table 11. Comparison of predicted and observed values on infection rate of southern rust on corn during spring crop, 1989 at Liu-chao

代號 No	預測方程式 Predicted equation	預測值 Predicted value	實測值[c] Observed value
1.	$R^a=-1.8281-0.0421X_2+0.4130X_5-0.0907X_{10}$ ($R^2=0.8810^{**b}$)	5.00	0.43
2.	$R=-0.2291-0.0352X_2+0.2428X_8-0.0492X_{10}$ ($R^2=0.8993^{**}$)	3.37	0.43
3.	$R=-1.1703-0.0366X_2+0.2405X_8-0.0315X_{11}$ ($R^2=0.8629^{*}$)	3.34	0.43
4.	$R=-1.2839-0.0369X_2+0.2797X_8-0.0491X_{12}$ ($R^2=0.9107^{**}$)	4.31	0.43
5.	$R=4.5268-0.0469X_4+0.1820X_6-0.0853X_{10}$ ($R^2=0.8591^{*}$)	0.32	0.43
6.	$R=3.7176-0.0522X_4+0.2182X_6-0.0902X_{12}$ ($R^2=0.8662^{*}$)	1.23	0.43
7.	$R=3.7086-0.0254X_3+0.1564X_8-0.0908X_{10}$ ($R^2=0.8429^{*}$)	0.47	0.43
8.	$R=3.0481-0.0349X_4+0.1271X_6-0.0569X_{10}$ ($R^2=0.8050^{*}$)	0.24	0.43
9.	$R=1.8326-0.0371X_4+0.1269X_6-0.0367X_{11}$ ($R^2=0.7590^{*}$)	0.08	0.43
10.	$R=1.8653-0.0338X_4+0.1115X_7-0.0513X_{10}$ ($R^2=0.7714^{*}$)	0.17	0.43
11.	$R=3.0801-0.0343X_4+0.0914X_9-0.0588X_{10}$ ($R^2=0.7419^{*}$)	0.47	0.43

[a] R爲侵染速率，X_2爲20.1～24.0℃累積小時數，X_3爲24.1～28.0℃累積小時數， X_4爲28.1～32.0℃累積小時數，X_5爲最高溫，X_6最低溫，X_7爲平均溫，X_8爲平均最高溫，X_9爲平均最低溫，X_{10}爲平均相對濕度，X_{11}爲平均最高濕度， X_{12}爲平均最低濕度。

[b] * 顯著，** 極顯著。

[c] 實測值爲M2玉米。

[a] R=Infection rate, X_2 =Accumulative hours 20.1～24.0℃, X_3 = Accumulative hours 24.1～28.0℃ , X_4 =Accumulative hours 28.1～32.0℃, X_5 =Highest temp., X_6=Lowest temp., X_7= Ave. temp., X_8 =Ave. highest temp., X_9=Ave. lowest temp., X_{10} =Ave. RH, X_{11} =Ave. highest RH. X_{12} =Ave. lowest RH.

[b] *Significant at 5% level, **Significant at 1% level.

[c] Observed value from cultivar M2.

表十二、銹病侵染速率之預測值與民國79年嘉義地區秋作實測值比較

Table 12. Comparison of predicted and observed values on infection rate of southern rust on corn rate during fall crop. 1990 at Chia-yi area

代號 No	預測方程式 Predicted equation	預測值 Predicted value	實測值 Observed value			
			義竹	六腳	朴子	蒜頭
1.	$R^a=-1.8281-0.0421X_2+0.4130X_5-0.0907X_{10}$ ($R^2=0.8810^{**b}$)	0.91	0.69	0.64	0.30	0.73
2.	$R=-0.2291-0.0352X_2+0.2428X_8-0.0492X_{10}$ ($R^2=0.8993^{**}$)	0.58	0.69	0.64	0.30	0.73
3.	$R=-1.1703-0.0366X_2+0.2405X_8-0.0315X_{11}$ ($R^2=0.8629^{*}$)	0.64	0.69	0.64	0.30	0.73
4.	$R=-1.2839-0.0369X_2+0.2797X_8-0.0491X_{12}$ ($R^2=0.9107^{**}$)	0.68	0.69	0.64	0.30	0.73
5.	$R=4.5268-0.0469X_4+0.1820X_6-0.0853X_{10}$ ($R^2=0.8591^{*}$)	1.14	0.69	0.64	0.30	0.73
6.	$R=3.7176-0.0522X_4+0.2182X_6-0.0902X_{12}$ ($R^2=0.8662^{*}$)	1.10	0.69	0.64	0.30	0.73
7.	$R=3.7086-0.0254X_3+0.1564X_8-0.0908X_{10}$ ($R^2=0.8429^{*}$)	0.38	0.69	0.64	0.30	0.73
8.	$R=3.0481-0.0349X_4+0.1271X_6-0.0569X_{10}$ ($R^2=0.8050^{*}$)	0.88	0.69	0.64	0.30	0.73
9.	$R=1.8326-0.0371X_4+0.1269X_6-0.0367X_{11}$ ($R^2=0.7590^{*}$)	0.93	0.69	0.64	0.30	0.73
10.	$R=1.8653-0.0338X_4+0.1115X_7-0.0513X_{10}$ ($R^2=0.7714^{*}$)	0.71	0.69	0.64	0.30	0.73
11.	$R=3.0801-0.0343X_4+0.0914X_9-0.0588X_{10}$ ($R^2=0.7419^{*}$)	0.79	0.69	0.64	0.30	0.73

[a] R為侵染速率，X_2為20.1～24.0℃累積小時數，X_3為24.1～28.0℃累積小時數，X_4為28.1～32.0℃累積小時數，X_5為最高溫，X_6最低溫，X_7為平均溫，X_8為平均最高溫，X_9為平均最低溫，X_{10}為平均相對濕度，X_{11}為平均最高濕度，X_{12}為平均最低濕度。

[b] * 顯著，** 極顯著。

[c] 實測值義竹為台南17號，六腳鄉為台農1號，朴子為台農1號，太保為哈蜜236。

[a] R=Infection rate, X_2=Accumulative hours 20.1～24.0℃, X_3=Accumulative hours 24.1～28.0℃, X_4=Accumulative hours 28.1～32.0℃, X_5=Highest temp., X_6=Lowest temp., X_7=Ave. temp., X_8=Ave. higest temp., X_9=Ave. lowest temp., X_{10}=Ave. RH, X_{11}=Ave. highest RH. X_{12}=Ave. lowest RH.

[b] * Significant at 5% level, ** Significant at 1% level.

[c] Observed value of I-tzu is Tainan 17, Liu-chao is Tainung 1, Pao-tzu is Tainung 1, Tai-pao is Honey 236.

表十三、銹病侵染速率之預測值與民國80年台中春作實測值比較

Table 13. Comparison of predicted and observed values on infection rate of southern rust on corn during spring crop, 1991 at Taichung

代號 No	預測方程式 Predicted equation	預測値 Predicted value	實測値 Observed values 品種 Cultivar TN17	TN5	TNG1	H41236	Honey	M2
1.	$R^a=-1.8281-0.0421X_2+0.4130X_5-0.0907X_{10}$ ($R^2=0.8810^{**b}$)	2.37	0.20	0.33	0.07	0.13	0.32	0.12
2.	$R=-0.2291-0.0352X_2+0.2428X_8-0.0492X_{10}$ ($R^2=0.8993^{**}$)	0.76	0.20	0.33	0.07	0.13	0.32	0.12
3.	$R=-1.1703-0.0366X_2+0.2405X_8-0.0315X_{11}$ ($R^2=0.8629^{*}$)	0.73	0.20	0.33	0.07	0.13	0.32	0.12
4.	$R=-1.2839-0.0369X_2+0.2797X_8-0.0491X_{12}$ ($R^2=0.9107^{**}$)	0.59	0.20	0.33	0.07	0.13	0.32	0.12
5.	$R=4.5268-0.0469X_4+0.1820X_6-0.0853X_{10}$ ($R^2=0.8591^{*}$)	0.51	0.20	0.33	0.07	0.13	0.32	0.12
6.	$R=3.7176-0.0522X_4+0.2182X_6-0.0902X_{12}$ ($R^2=0.8662^{*}$)	0.90	0.20	0.33	0.07	0.13	0.32	0.12
7.	$R=3.7086-0.0254X_3+0.1564X_8-0.0908X_{10}$ ($R^2=0.8429^{*}$)	0.49	0.20	0.33	0.07	0.13	0.32	0.12
8.	$R=3.0481-0.0349X_4+0.1271X_6-0.0569X_{10}$ ($R^2=0.8050^{*}$)	0.31	0.20	0.33	0.07	0.13	0.32	0.12
9.	$R=1.8326-0.0371X_4+0.1269X_6-0.0367X_{11}$ ($R^2=0.7590^{*}$)	0.13	0.20	0.33	0.07	0.13	0.32	0.12
10.	$R=1.8653-0.0338X_4+0.1115X_7-0.0513X_{10}$ ($R^2=0.7714^{*}$)	0.52	0.20	0.33	0.07	0.13	0.32	0.12
11.	$R=3.0801-0.0343X_4+0.0914X_9-0.0588X_{10}$ ($R^2=0.7419^{*}$)	0.79	0.20	0.33	0.07	0.13	0.32	0.12

[a] R爲侵染速率，X_2爲20.1～24.0℃累積小時數，X_3爲24.1～28.0℃累積小時數， X_4爲28.1～32.0℃累積小時數，X_5爲最高溫，X_6最低溫，X_7爲平均溫，X_8爲平均最高溫，X_9爲平均最低溫，X_{10}爲平均相對濕度，X_{11}爲平均最高濕度，X_{12}爲平均最低濕度。

[b] * 顯著，** 極顯著。

[a] R=Infection rate, X_2=Accumulative hours 20.1～24.0℃, X_3=Accumulative hours 24.1～28.0℃, X_4=Accumulative hours 28.1～32.0℃, X_5 =Highest temp., X_6=Lowest temp., X_7= Ave. temp., X_8 =Ave. highest temp., X_9=Ave. lowest temp., X_{10} =Ave. RH, X_{11}=Ave. highest RH. X_{12} =Ave. lowest RH.

[b] * Significant at 5% level, ** Significant at 1% level.

產量損失

Russell[14]在1965年報告，利用6個雜交組合，經過兩年的結果，普通型銹病引起之子實產量損失在15.3～23.5% (表十四)。Kim 及 Brewbaker[9]在1976年報告普通型銹病對產量及農藝性狀的影響，子實產量減少35%，鮮草重減少27%，穗長有 11%之差異，子粒重及穗徑有 5% 之差異 (表十五～十八)。Martinez [10] 1977年報告普通型銹病引起之子實產量損失約爲17%(表十九)。

表十四、普通型銹病 (*Puccinia sorghi*) 影響雜交組合 (B14A, B14) 子實產量的比較
Table 14. Comparisons of B14A and B14 crosses for grain yields in pounds per plot at 15.5 % moisture under artificial epiphytotics of *Puccinia sorghi* averaged over 2 years

Cross	B14A	B14	Difference % of B14A
RI68	17.6	14.9	15.3
Oh7K	17.0	13.0	23.5
Oh4I	19.9	15.8	20.6
Average	18.2	14.6	19.8

(Russell, W. A. 1965)

表十五、銹病在抗病和感病雜交品系上造成子實產量損失
Table 15. Grain yield of resistant and susceptible hybrids and reduction due to rust

	Grain yield (quintals/ha)				Percent reduction due to rust		
	Summer		Winter				
Hybrid	Res.	Sus.	Res.	Sus.	Summer	Winter	Mean
662	115.1	89.7	48.3	24.8	22.1	48.7	35.4
665	129.7	81.1	32.1	25.2	37.5	21.5	29.5
669	119.5	89.7	36.6	9.0	24.9	75.4	50.1
672	114.1	68.1	37.7	9.6	40.3	74.5	57.4
676	128.1	94.1	45.0	29.0	26.5	35.6	31.1
678	116.8	83.3	31.0	14.1	28.3	54.5	41.4
681	124.3	96.8	26.8	18.7	22.1	30.2	26.2
688	115.1	80.5	31.9	30.1	30.1	5.6	17.9
691	110.3	85.9	36.6	16.6	22.1	54.6	38.4
695	107.0	94.1	43.4	31.5	12.1	27.4	34.7
Mean	118.0	86.4	36.9	20.9	26.6	42.8	34.7
B.L.S.D. (0.05)	29.49		15.59				

(Kim, S. K., and Brewbaker, J. L. 1976)

表十六、銹病在抗病和感病雜交品系上造成之鮮草重損失

Table 16. Fresh plant weight with ear of resistant and susceptible hybrids and reduction due to rust

	Plant wt (metric tons/ha)				Percent reduction due to rust		
	Summer		Winter				
Hybrid	Res.	Sus.	Res.	Sus.	Summer	Winter	Mean
662	45.8	32.9	26.9	16.1	28.3	40.4	34.4
665	46.8	35.1	21.3	17.3	25.1	18.8	22.0
669	48.9	36.4	25.0	17.2	25.6	31.0	28.3
672	50.7	29.3	23.1	17.0	42.2	26.7	34.5
676	51.9	37.3	25.8	20.0	28.1	22.6	25.4
678	48.3	31.5	21.8	14.8	34.7	32.2	33.5
681	52.3	44.0	24.5	18.9	15.9	23.0	19.5
688	53.9	41.6	32.4	23.1	22.9	28.5	25.7
691	44.9	37.2	30.1	20.2	17.0	32.7	24.8
695	50.5	41.5	26.2	21.4	17.9	18.2	18.0
Mean	49.4	36.7	25.7	18.6	25.8	27.4	26.6
B.L.S.D. (0.05)	9.05		4.76				

(Kim, S. K., and Brewbaker, J. L. 1976)

表十七、銹病在10種玉米雜交品系上造成之子粒重及穗徑損失

Table 17. Reductions of kernel weights and ear diameters due to rust for 10 corn hybrids

	Percent reduction due to rust			
	Kernel wt		Ear diam.	
Hybrid	Summer	Winter	Summer	Winter
662	2.9	20.3	3.2	17.5
665	12.1	10.6	5.6	5.5
669	10.6	19.3	11.5	31.4
672	8.2	10.9	4.1	20.1
676	2.3	17.3	2.0	15.4
678	10.0	20.1	4.4	15.7
681	19.5	7.5	15.7	6.2
688	6.4	4.4	7.6	-6.7
691	-0.7	11.9	-2.9	19.4
695	-1.3	5.6	2.2	15.2
Mean	7.0	12.8	5.3	14.0

(Kim, S. K., and Brewbaker, J. L. 1976)

表十八、銹病在抗病和感病雜交品系上造成之穗長損失
Table 18. Ear length (filled) of resistant and susceptible hybrids and reduction due to rust

Hybrid	Ear length (cm) Summer Res.	Summer Sus.	Winter Res.	Winter Sus.	Percent reduction due to rust Summer	Winter	Mean
662	17.6	15.8	11.1	9.3	10.1	16.3	13.2
665	17.7	16.4	10.5	8.2	7.4	22.1	14.8
669	18.9	15.6	9.3	7.9	17.3	14.7	16.0
672	18.3	15.7	10.6	10.4	13.9	1.5	7.7
676	16.0	14.2	10.3	8.5	11.0	17.8	14.4
678	16.0	13.6	9.7	7.2	15.0	24.9	20.0
681	17.5	15.7	7.9	7.9	10.2	0.3	5.3
688	18.0	16.3	10.0	9.6	9.4	3.8	6.6
691	15.6	14.6	9.1	8.9	5.9	2.6	4.3
695	18.0	16.5	10.2	9.7	8.3	4.9	6.6
Mean	17.4	15.5	9.9	8.8	10.8	10.9	10.9
B.L.S.D. (0.05)	4.19		2.03				

(Kim, S. K., and Brewbaker, J. L. 1976)

表十九、普通型銹病（*Puccinia sorghi*）對產量的影響
Table 19. Effects of *Puccinia sorghi* on yield

Year[a]	Treatment	Rust %	Yield(kg/ha)	Difference(%)
1974/75	With chemical control	2.15	6,187.00	17.32
	Without chemical control	30.46	5,116.00	
1975/76	With chemical control	2.46	5,735.00	18.60
	Without chemical control	25.29	4,666.00	

(Martinez, C. A. 1977)

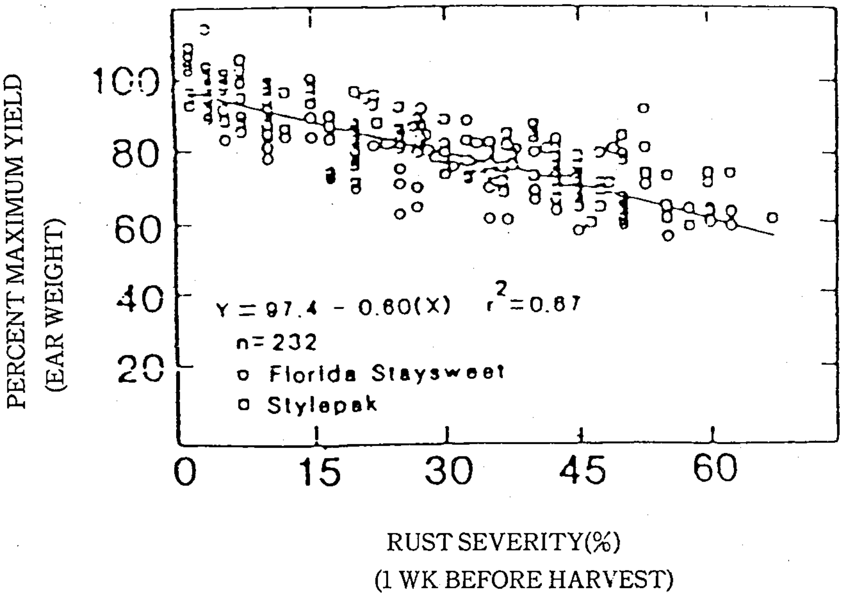
[a] In both years treatments are significantly different at 0.01 level (F test).

Randle等[12]1984年利用兩個甜玉米雜交品系〝Jubilee〞(中感)及〝Stylepak〞(極感)觀察普通型銹病對農藝性狀之影響，結果顯示在銹病發生區及對照區在吐絲指數、果穗含水率、穗長、穗莖及糖度均有明顯的差異(表二十)。Pataky[11] 1987年報告利用甜玉米Gold Cup(中抗，鮮食用)、Stylepak(感病，加工用)及Florida Staysweet (感病，鮮食或加工用)來比較普通型銹病引起之產量損失，結果顯示在收穫前一週調查時每10%銹病引起6%穗重及6.5%穗數之損失(圖四、五)。在南方型銹病方面，Rodriguez-Ardon 等[13] 1980年報告，利用感病雜交品系在1978年，每年從5月25日開始每隔兩週種植一次，共種三次，銹病引起之子實產量減產4、23及45%，晚植者產量損失特別高。

表二十、普通型銹病對兩個甜玉米雜交品系（Jubilee, Stylepak）5個性狀的差異
Table 20. Means for 5 characters of 〝Jubilee〞 and 〝Stylepak〞 sweet corn subjected to high rust and low rust conditions in 2 years

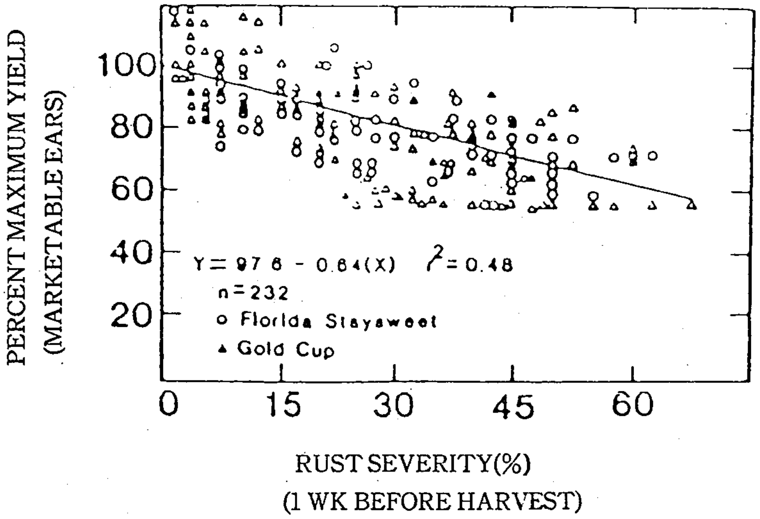
Hybrid	Treatment		
	Control	Rusted	Mean
	Silking index		
Jubilee	2.90	3.61	3.26
Stylepak	3.69	5.18	4.44
Mean	3.29	4.39	
LSD 0.05	0.40	0.40	
	Moisture (%)		
Jubilee	70.40	68.90	69.70
Stylepak	72.90	68.60	70.80
Mean	71.70	68.80	
LSD 0.05	2.20	2.20	
	Ear length (mm)		
Jubilee	207.00	202.00	205.00
Stylepak	224.00	201.00	213.00
Mean	216.00	202.00	
LSD 0.05	9.00	9.00	
	Ear diameter (mm)		
Jubilee	48.00	44.40	46.20
Stylepak	49.10	45.00	47.10
Mean	18.60	44.70	
LSD 0.05	2.40	2.40	
	Brix (%)		
Jubilee	25.20	24.70	24.90
Stylepak	21.90	20.60	21.20
Mean	23.60	22.60	
LSD 0.05	0.90	0.90	

(Randle, W. M., Davis, D. W., and Groth, J. V. 1984)



圖四、1984、1985及1986年田間試驗評估，收穫前一週銹病對甜玉米雜交品系 Florida Staysweet，Stylepak最大穗重百分率的迴歸。(Pataky, J. K. 1987)

Fig. 4. Regression of percent maximum sweet corn ear weight on rust severity 1 wk before harvest for combined data of Florida Staysweet and Stylepak evaluated in 1984, 1985 and 1986 field trials.



圖五、1984、1985及1986年田間試驗評估，收穫前一週銹病對甜玉米雜交品系 Florida Staysweet，Gold Cup最大穗數百分率的迴歸。(Pataky, J. K. 1987)

Fig. 5. Regression of percent maximum number of marktable sweet corn ears on rust severity 1 wk before harvest for combined data of Florida Staysweet and Gold Cup evaluated in 1984, 1985 and 1986 field trials.

結　　論

雖然目前本省有普通型及南方型兩種銹病，但實際上南方型比普通型普遍。由於玉米銹病田間發生與氣象因子關係之研究，從民國七十八年才開始，所得到的資料有限，故本報告僅能就病勢進展，銹病和氣象因子之關係，病斑面積率增加及侵染速率和氣象因子之關係等提出討論。有關產量損失因尚缺資料，亦僅能就外國的資料加以說明。在病斑面積率增加及侵染速率和氣象因子之關係，已分別得到數個方程式，這些方程式以不同年代之氣象因子代入以後，所得到的預測值和實測值均甚接近，應可做爲預測的依據。當然，今後繼續收集更多的資料以修改及驗証方程式是有其必要的。

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ABSTRACT

Tsai, W. H. and Tsai .J.N. 1992. Occurrence and meteorological factors of corn rust disease and yield losses. Plant Prot. Bull. 34:80-100. (Taiwan Agricultural Research Institute, Wu-feng, Taichung, Taiwan, R.O.C.)

Two kinds of corn rust, common rust (*Puccinia sorghi*) and southern rust (*P. polysora*) were found in Taiwan. However, southern rust is more wide-spread at present. Disease development of corn rust showed quadratic regression curve equations in general, but it showed linear equations when the disease was serious. By analyzing the single correlation of rust and meteorolgical factors, it indicated that the most important factors were temperature 24.1～28.0℃ and 28.1～ 32.0℃ seven days before disease occurrence during spring crop, and 20.1～24.0℃ 、24.1～28. 0℃ 、28.1～32.0℃ 8～14 days before disease occurrence during fall crop. By analyzing the relationship between increasing infected leaf area percentage and meteorological factors, 8 equations were obtained, while 11 equations were obtained from the relationship between infection rate and meteorological factors. Those equations were derived from fall crop of 1990 at Chia-yi area. The predicted values from those equations obtained were very close to the observed values, therefore, it is suggested that those equations might be used for predicting rust disease of corn.

For yield losses caused by rust disease, not much information was found in Taiwan. Russell in 1965 reported that the losses on grain yields caused by common rust were 15.3～23.5% after 2 years' tests on 6 crosses. Kim and Brew- baker in 1976 indicated that the effects of common rust on grain yield was 35%, fresh plant weight with ear was 27%, ear length was 11%, 10% on ear diameter, and 5% difference on plant height, ear height, and silking stage. Randle et al in 1984 by using two sweet corn lines Jubilee (moderate susceptible) and Stylepak (susceptible) to observe the differnces on agronomic characteristics, the results showed that the silking stage, ear length, ear diameter and ear water content were quite different on rusted and non-rusted plots. Pataky in 1987 estimated that yield reduction due to common rust on Gold Cup (moderate resistant), Stylepak (susceptible) and Florida Staysweet (susceptible) was 6% of the maximum total ear weight and 6.5% of the maximum total number of marketable ears for each 10% rust severity. Rodriguez-Ardon et al showed that on susceptible hybrids, in three biweekly plantings (beginning about 25 May) in 1976 and 1978, southern rust caused average yield reductions of 4 、23 and 45% respectively.

(Key words：corn rust, meteorological factors, yield losses)